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Glands of the Ciliary Body

Leslie Buchanan

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THE GLANDS OF THE CILIARY BODY.

By Leslie Buchanan, M.B. Glas., *Pathologist, Glasgow Eye Infirmary.* (Plate X.)

In the *Archives D'Ophthalmolgie*, 1890–1891, there appeared a series of articles by Dr Nicati of Marseilles, in which the results of a long series of experiments and observations regarding the origin of the aqueous fluid in some of the lower animals were made known.

In summing up his results, Dr Nicati states that the aqueous fluid is secreted by the epithelium of the pars retinæ ciliaris together with the vascular and lymphatic channels surrounding this part, which, taken together, he terms the uveal gland.

At the same time, namely early in 1891, Mr Treacher Collins, in an article published in the *Transactions of the Ophthalmological Society*, took a step in advance, in showing for the first time the existence of glands by means of which the secretion of the fluid might be accomplished in the human and other subjects.

By the use of bleaching agents, Mr Collins was enabled to show that certain outgrowths from the pigment epithelium of the ciliary region were true glandular structures; and he stated that he considered that these might possibly take part in the secretion of the aqueous fluid.

Since Mr Collins' paper was published, but little evidence has been brought forward corroborating his observations, whilst many criticisms, more or less adverse, have been made; hence it has been thought wise to publish the results of some recent work which agrees in most respects with that of Mr Collins, and to illustrate, so far as possible, by means of photomicrograms sections of the glandular structures under various conditions. Before doing so, however, it may be well to recall a few points in connection with the aqueous fluid, and with the anatomy of the ciliary body.

The aqueous fluid is a limpid fluid, containing but a small percentage of albumen and but a trace of salts, which fills the

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anterior and posterior chambers, permeates the vitreous body, and acts, most probably, as a nutrient medium for both this and the crystalline lens. It is the aqueous fluid which serves to keep in health the tension of the eyeball at a normal standard, by means of a well regulated adjustment acting on the local vascular system.

From pathological and experimental results, it is found that the fluid is secreted behind the iris, that part of its current passes backwards through the vitreous body, whilst the remainder passes forwards to and through the pupil into the anterior chamber, whence it escapes by the spaces of Fontana into the canal of Schlemm.

By the fact that when the iris is either absent from birth, or is removed *in toto* by accident or by operation, the tension of the eyeball is maintained at the normal standard, it is rendered most probable that the iris itself is not even a principal source of aqueous fluid. When the ciliary body is excised, as has been done, the ocular tension falls, and the secretion of the aqueous fluid ceases, showing that this part of the eye, at all events, is intimately concerned with the elaboration of the fluid.

Referring now to the anatomy of the ciliary body, it is found that the ciliary region, which extends from the base of the iris to the ora serrata, is divided into an anterior thickened and folded portion and a posterior smooth portion, termed respectively the "pars plicata" and the "pars non-plicata."

Two sets of elements enter into the formation of the ciliary body, namely, one derived from the choroid, and consisting of the muscular and vascular systems, and the other, the pars ciliaris retinæ, derived from the retina, which lines, as it were, the former set internally, and is separated from it by a hyaline lamina.

With this set of retinal elements we are specially concerned, it being the secreting area, as it were, of the aqueous fluid.

It is composed of an internal layer of elongated columnar epithelial cells, which is a continuation of the main body of the retina forwards from the ora serrata, and an external layer of cubical, deeply pigmented epithelial cells, which is continuous with the layer of hexagonal cells of the retina.

It is from this pigmented layer of cells that little processes

or outgrowths arise, which are easily seen in most radial sections of the ciliary body, lying internal to and abutting upon the hyaline lamina, and which Mr Treacher Collins was first to describe as true glandular structures.

These processes vary in size, are mostly single, sometimes branched, and are always deeply pigmented. They are generally pear- or club-shaped, and vary in number in the two parts of the ciliary body.

In the pars plicata the processes are only found at the posterior portion, but they are here most constantly seen and are of largest size, measuring from ·15 to ·10 mm. long, and from ·10 to ·05 mm. broad, and averaging five in a section.

In the pars non-plicata the processes are found to be smaller, measuring only ·06 to ·04 mm. long and ·04 to ·03 broad, they are in much greater numbers than elsewhere, averaging 25 per section, but often found to the number of over 100 per section, and are not of constant occurrence.

In the pars non-plicata there is sometimes a thickened portion, where a group of glands closely packed together may be found. It appears to be the case that the processes are of almost uniform occurrence round the whole ciliary region.

By taking an average of twenty-five processes per section, and estimating from the thickness of the sections the diameter of the glands and the circumference of the ciliary body, it may be computed that the total number in an eye may be 10,000.

Referring to Plate X., fig. 1 is a drawing, from a photograph, to represent the ciliary body; and in its posterior surface, near the posterior limit of the pars plicata, there are seen three such processes as above referred to. These processes are pear-shaped in section, are smaller than the sulci, from which they must be distinguished, and further, that one of them has a lumen, and an opening upon the surface of the ciliary body, and one only.

The glands must be carefully distinguished from transverse sections of sulci; and it may be seen that sulci, cut across, must almost all have a surface opening, whilst, on account of the narrow nature of the lumen, it is extremely rare to find a gland having such an opening.

Fig. 2 shows the group of glands seen in fig. 1 as three small processes magnified highly; and here, on account of the lightness

of the pigment in the original, the glandular nature is easily seen; a basement membrane bounding a cavity lined by large cells of epithelial nature, and having an opening upon the surface in one instance only.

Fig. 3 shows the position and appearance of the processes or glands in the pars non-plicata, with the relations of the structures to the epithelium above, and the fibrous tissue and vascular system underneath.

Fig. 4 represents the same portion of the ciliary body deprived by bleaching, of its natural pigment, and allowing the relationship to be more easily seen.

Fig. 5 shows the appearances seen on making tangential sections of the pars non-plicata, and consequently getting transverse sections of the glands.

Fig. 6 is drawn from the same section after bleaching, and shows very clearly the transverse section of the tube of a gland, namely, a ring of epithelial cells, with a central lumen.

In these sections one or two capillary blood-vessels are seen, lying near the glandular structures.

From these appearances seen in the various figures, it is obvious that the so-called processes are truly glandular structures, and are not either sulci or solid pegs of epithelial cells, as has been said of them by some, for the undoubted presence of a lumen in certain instances renders this latter view almost entirely impossible.

For further evidence, sections of the ciliary body in various diseases have been examined. Figs. 7 and 8 represent a portion of the pars plicata in a condition of acute inflammation (cyclitis), and it is seen that the glands are elongated, distorted and dilated to a marked extent, and probably are secreting more fluid and a more highly albuminous fluid than normal, whereas in fig. 9 the state of cicatricial formation destroying the epithelium, has caused almost entire destruction of the gland and its epithelium, and also its functional activity. Several diseases of the eye have been shown to be in connection with these structures; but in general only one circumstance must be mentioned, namely, that in cases of acute inflammation the tension of the eyeball is increased, whilst in cases of chronic inflammation of the uveal tract or ciliary body the tension of the eyeball is lowered per-

manently if the ciliary body be atrophied, but temporarily if only blocked up.

Regarding the function of these glandular structures, it may be said that nothing definite is known; but on taking into account their position, their glandular appearance, and intimate connection with the vascular system, and finally the fact that, so far as is known, only one fluid is secreted in the eyeball, it seems very highly probable that these structures are in some way connected with the elaboration of it. Further, if it be asked, Are these structures present in sufficient numbers, presuming that they do secrete aqueous fluid, to secrete it so quickly as to satisfy the demands of the occasion? it may surely be answered in the affirmative. For, even though the aqueous fluid be supplied in sufficient quantity to refill the anterior chamber, after evacuation, in five minutes, it is not necessarily new secretion, but fluid drained forward from the vitreous, which replaces that drawn off; and lastly, the tension being lowered, the secretion will certainly take place more quickly.

As the methods of preparing the specimens have been somewhat different from those usually employed, a few words may be permissible regarding them.

The eyeballs were hardened in a weak solution of chromic and acetic acids, four days sufficing to complete the process. Sections were cut in gum, and stained in Kleinenberg's hæmatoxylin, and after staining, cleared with acetic acid and mounted in glycerine.

Sections to be bleached were immersed in a solution of euchlorine for twelve to twenty-four hours, washed for six hours in water, and stained as above.

The euchlorine solution was prepared as follows:—One dram of chlorate of potash was put in a stoppered bottle, and three drams of strong muriatic acid poured upon it, and the whole well shaken. Then, after five minutes or so, three ounces of water were poured into the bottle, and the whole again shaken. The result is a solution of a greenish-yellow gas in water, and consists of a mixture of chloric and chlorous acids and free chlorine.

Notwithstanding the fact that the sections have been immersed for such a prolonged period in such a highly acid solution, no damage seems to have resulted.

Photography was performed by means of Zeiss apochrom. objs. 35 mm. and 8 mm. 2 and 4 oculars (project.).

I have also to acknowledge here my indebtedness to Dr Campbell M'Clure, of Glasgow, who has kindly drawn the diagrams in the Plate from my photo-micrograms.

EXPLANATION OF PLATE X.

Fig. 1. Radial section of pars plicata of the ciliary body, showing a group of three glands, one of which has an indication of an orifice at the surface. × 40. *a*, glandular structures; *b*, duct and orifice; *c*, blood-vessel; *S*, Selerotic coat; *M*, ciliary muscle; *E*, epithelial layers.

Fig. 2. Portion of No. 1, including the glands, showing duct and orifice of one, whilst two others have no opening. (Lettering as above.) × 350.

Fig. 3. Radial section of pars non-plicata of ciliary body, showing numerous glandular structures lying in different planes, and causing slight elevation of the epithelium. (Lettering as before.) × 100.

Fig. 4. Part of the same section as No. 3, bleached, showing a blood-vessel lying amongst the glandular structures. (Lettering as above.) × 150.

Fig. 5. Tangential section of pars non-plicata, showing a group of glands, most of which have a distinct central orifice. × 350. (Lettering as above.)

Fig. 6. Part of No. 5, bleached, showing similar structures more distinctly. × 350. (Lettering as above.)

Fig. 7. Part of the ciliary body from a case of acute cyclitis, showing glandular structures elongated and dilated, bleached. × 200. (Lettering as above.)

Fig. 8. Part of fig. 7 more highly magnified, showing clearly the tube of the gland dilated and elongated. × 350.

Fig. 9. Part of the ciliary body in chronic cyclitis, showing atrophy and destruction of the epithelium, and great formation of fibrous tissue. × 200. (Lettering as above.)

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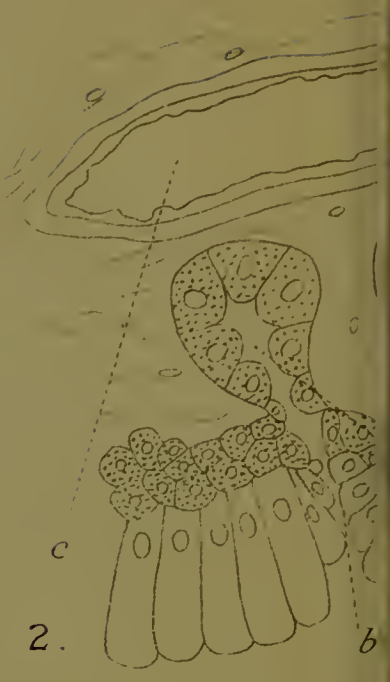

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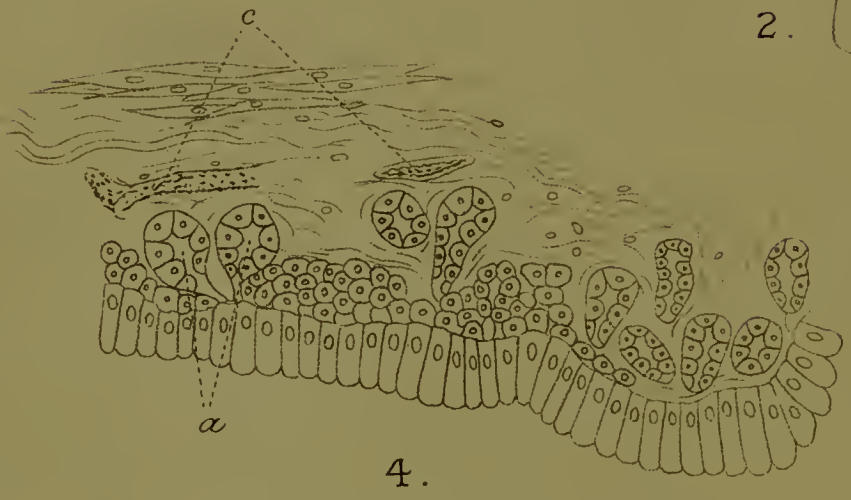

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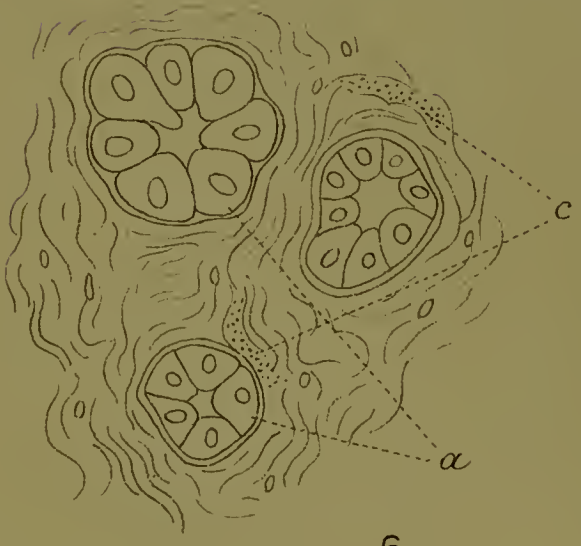

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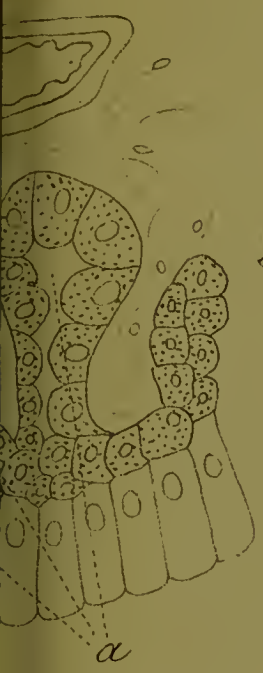

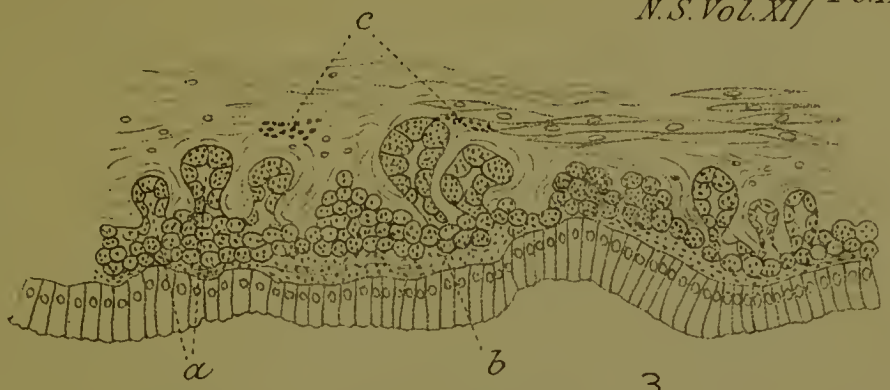

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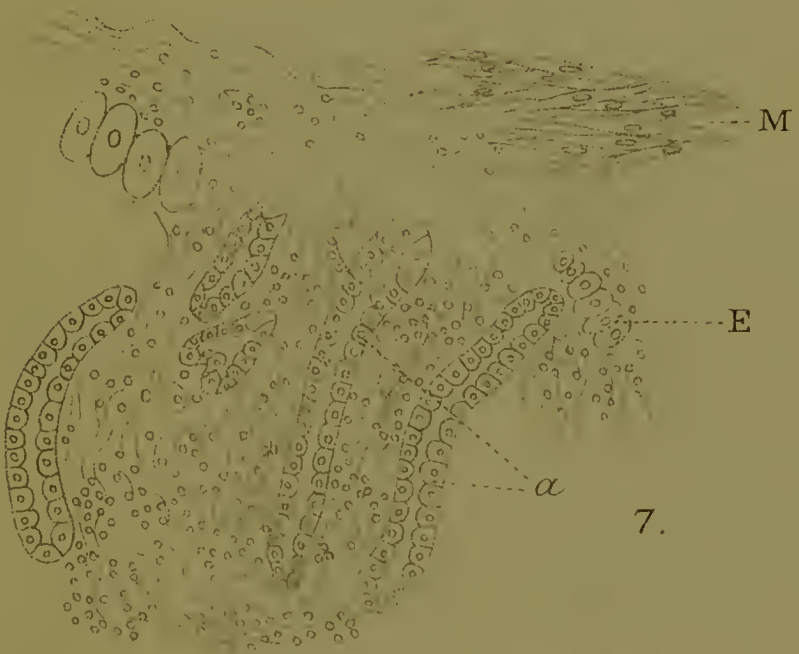

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